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INT CL⁴ B07C, B65G

(54) A method of and apparatus for controlling the unloading from carriages or like units of items to be sorted in a sorting plant

(57) In a method of controlling the unloading functions in a sorting plant of the kind comprising a plurality of carriages or like units, each of which is provided with a movable belt (12) operable to move orthogonally to the direction of the carriage or unit to unload items carried on the belt (12), the acceleration of the belt (12) is varied during the unloading stage, to control the trajectory and velocity of the item being unloaded, as a function of the mass of the item. The apparatus for carrying out the method includes a plurality of magnets (30) secured to the idler roller (29) of the belt (12), and a plurality of sensors to detect variation in the magnetic flux following rotation of the roller (29) in order to generate an electric signal which is compared to a reference signal and used to vary the current supply to the drive motor of the belt (12) to achieve the desir d acceleration.

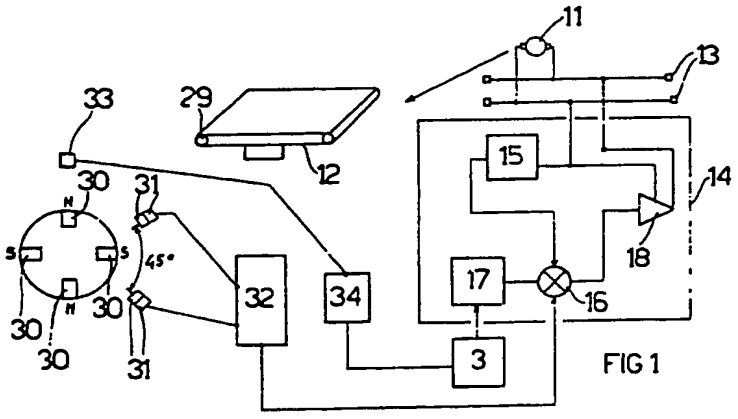

FIG 1

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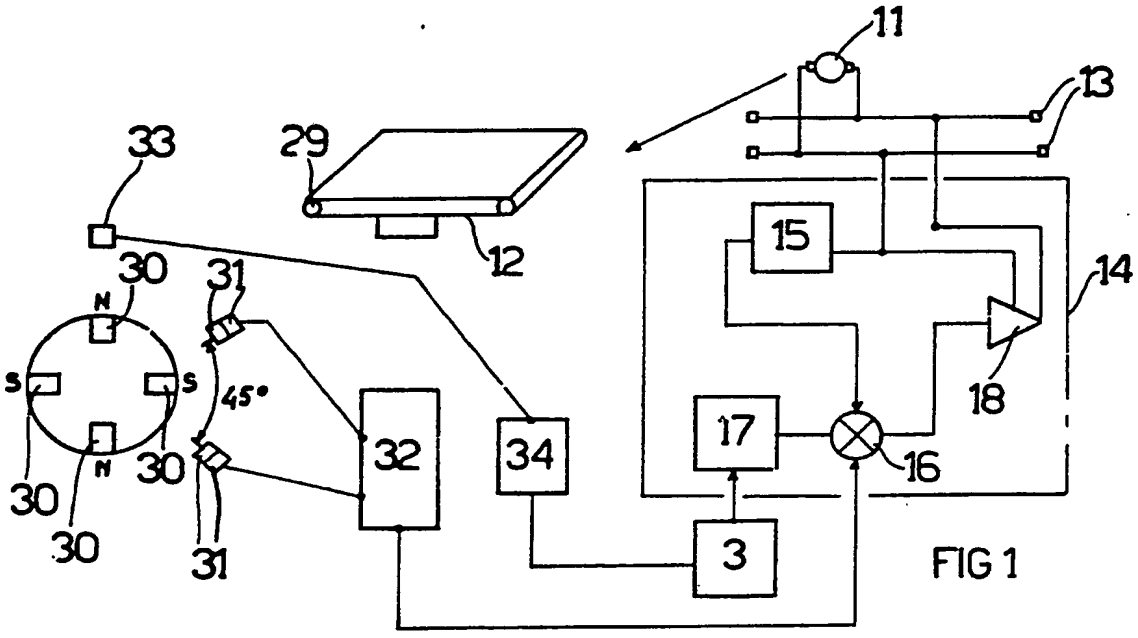

FIG 1

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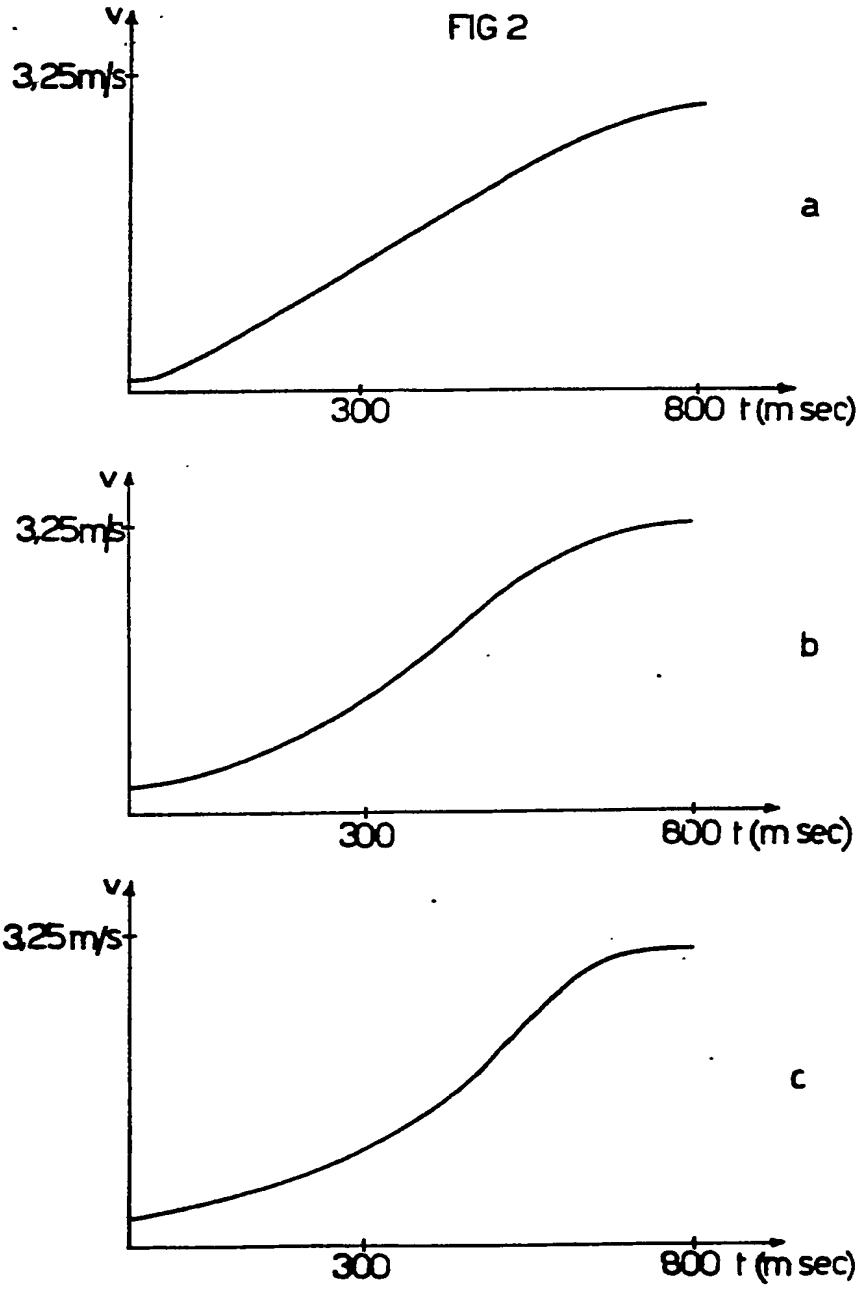
FIG 2



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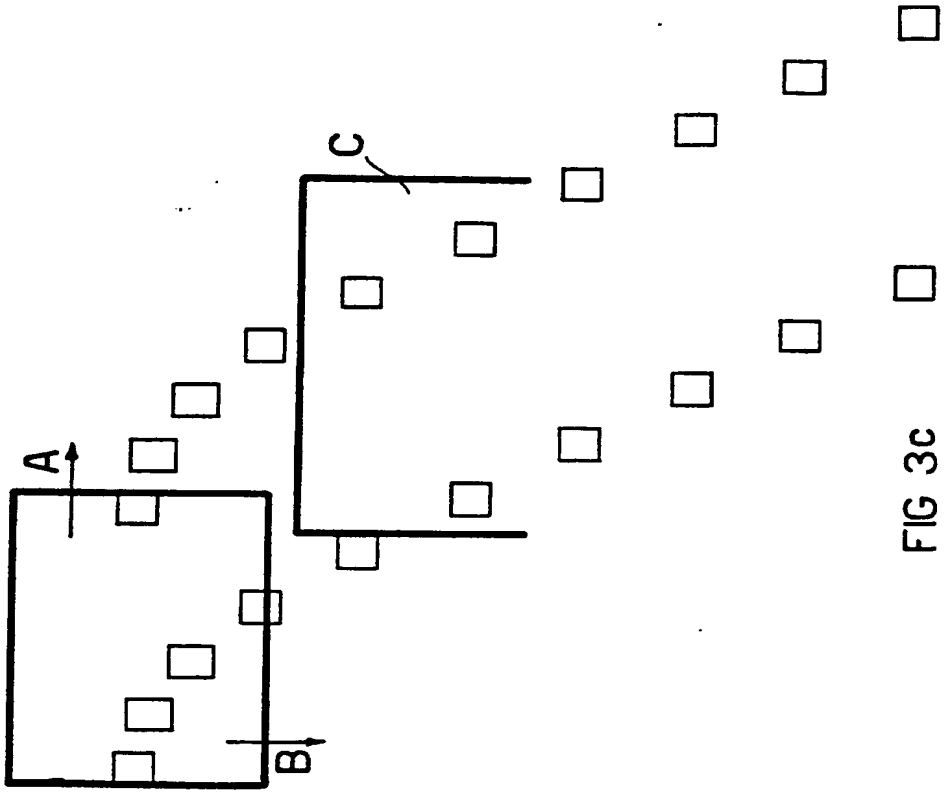

FIG 3c

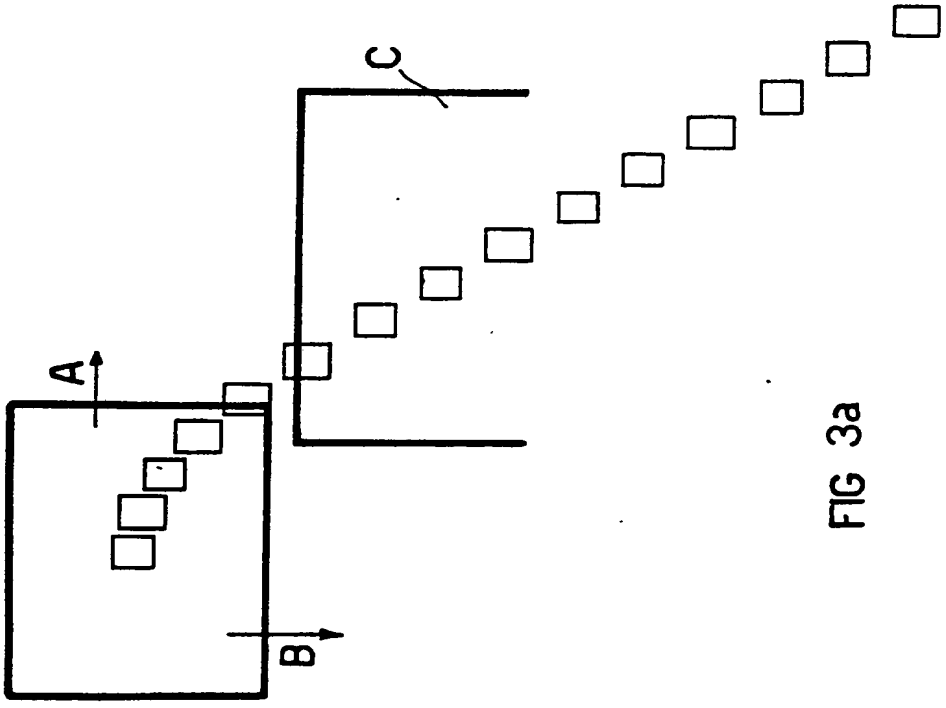

FIG 3a

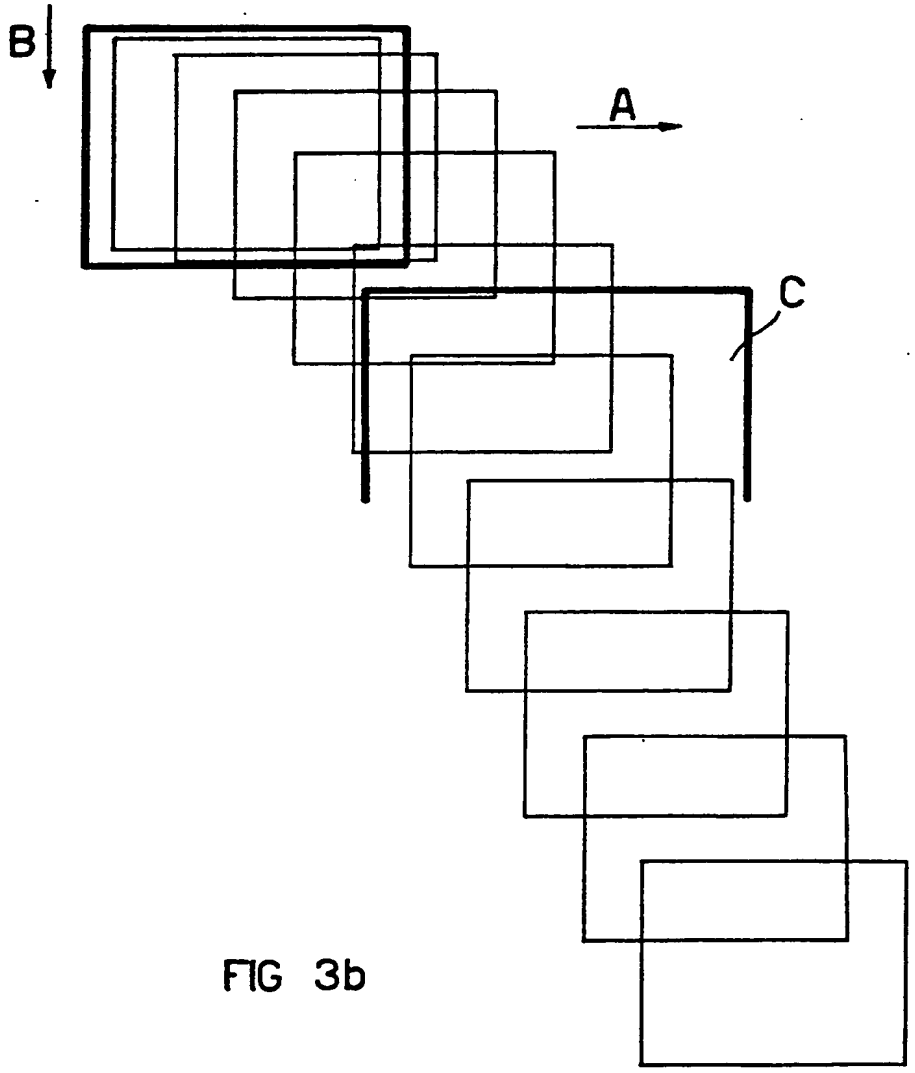

FIG 3b

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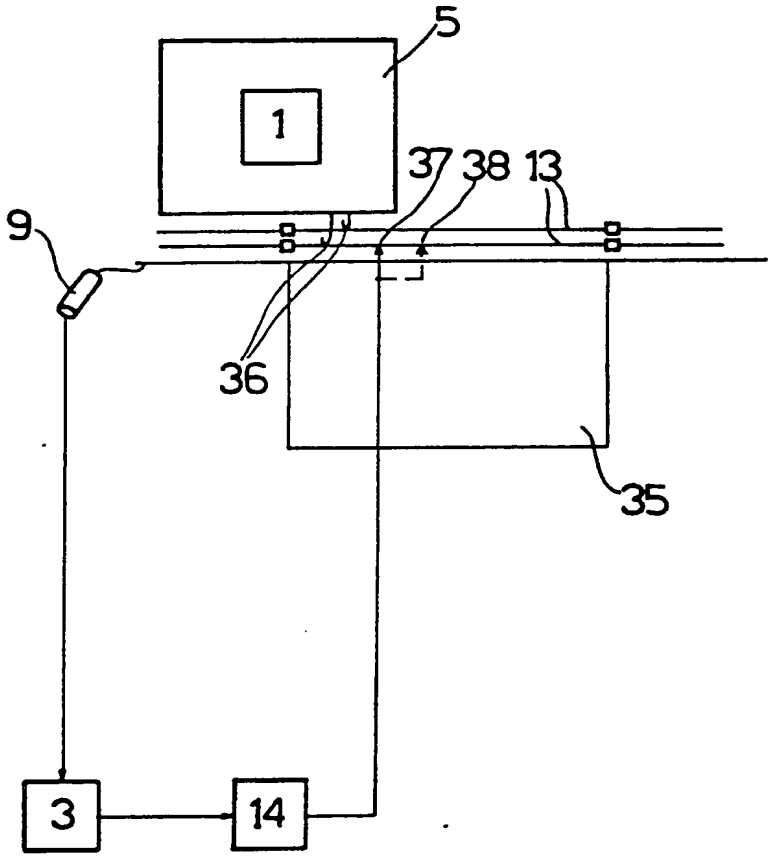

FIG 4

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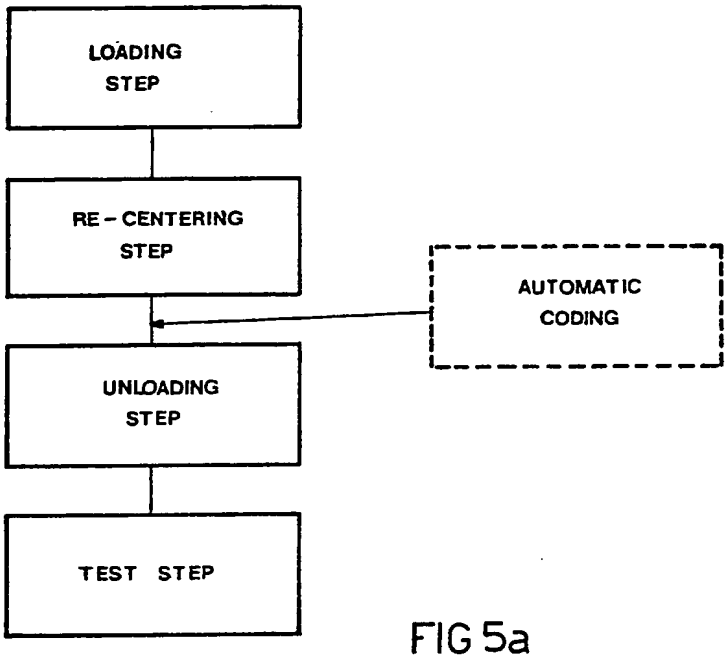

FIG 5a

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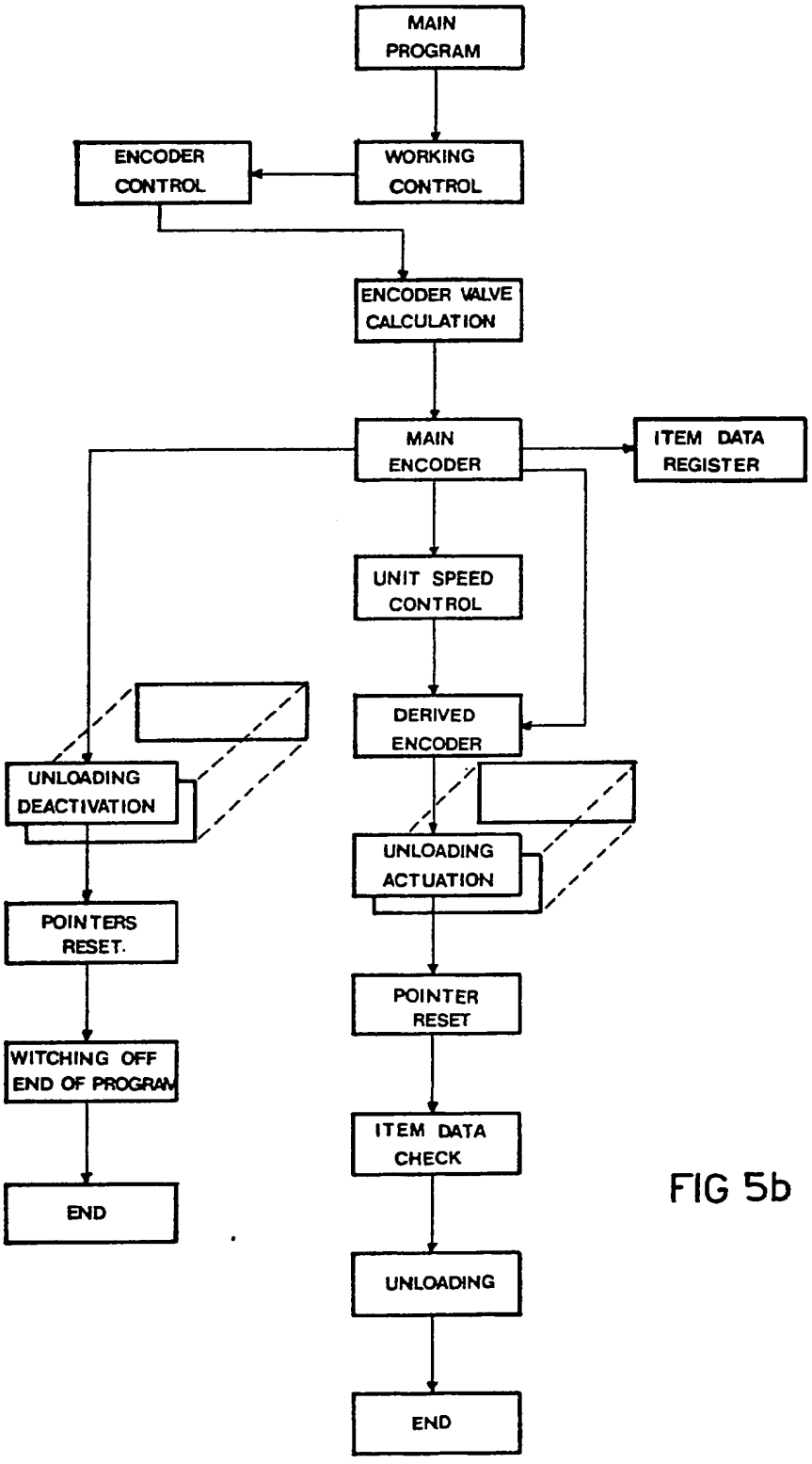

FIG 5b

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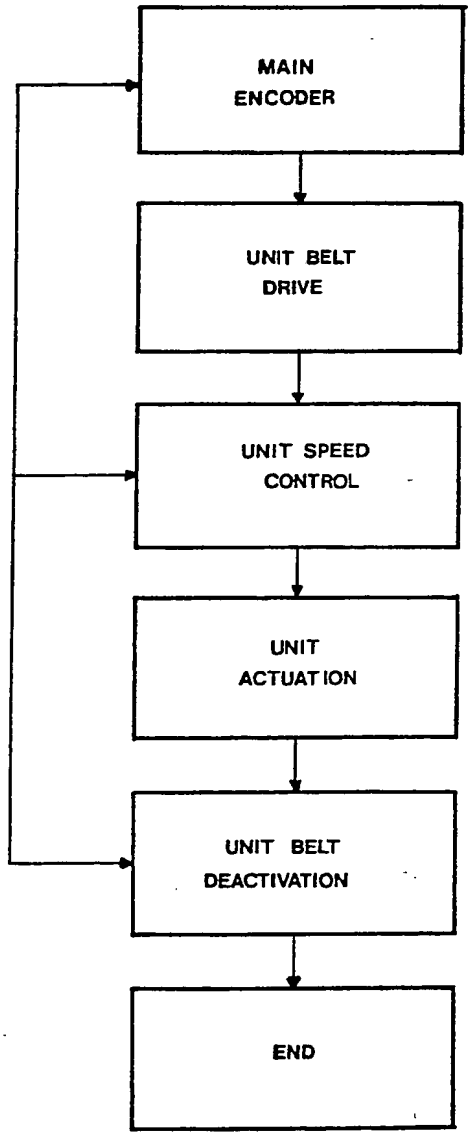

FIG 5c

A METHOD OF AND APPARATUS FOR CONTROLLING THE UNLOADING FROM CARRIAGES OR LIKE UNITS OF ITEMS TO BE SORTED IN A SORTING PLANT

This invention relates to a method of and apparatus for controlling the unloading from carriages or like units of items to be sorted in a sorting plant of the kind used when considerable numbers of items have to be sorted, such as in post offices, in mail order companies and the like.

These are sorting plants where the different functions are carried out and synchronised by a central computer that controls the course of the operations.

A standard sorting plant of this kind includes a fixed path along which run one or more carriages or like "units" on which the items to be sorted are placed. These items are automatically unloaded when the relevant carriage passes before a pre-determined collecting area, by means of computer controlled and actuated devices.

Plants of this kind are described in the following Italian patents and/or applications by the present Applicant:

Patent No's. 1 152 067 and 1 151 648, Utility Model No 180 770; and Applications No's. 22476 C/83, 21310 B/85, 24227 B/85, 25859 A/81, 21774 B/82, 23110 A/84, 22264 A/84 and 20779 A/85. In such plants each item is coded by an operator and placed on the sorting circuit in loading stations the number of which varies as a function of the amount of items to be sorted.

Along this circuit, which may have any desired shape or size, runs a train of carriages or like units that occupy either the whole part or just a part thereof.

The carriages or like units are movable by conventional ways, for instance by a continuous driving chain (when the path is substantially linear) or by electric motors on board the carriages or like units themselves and fed by electric current from power bars to the path (when the path is a

carrousel).

The items, carried by the carriages or like units, reach the collecting or discharge stations where they are unloaded. The unloading is carried out by means of movable belts that form the loading surface of the carriage or like units. At the moment of unloading, the belt on the carriage or like unit is operated by supplying current to the relevant belt drive motor via bus bars (different from the power bars and sectioned in correspondence to the unloading stations) in order to drive only the belt that is involved in the unloading.

Such unloading may take place at either side of the sorting path simply by reversing the direction of movement of the belt, which direction of movement (i.e. rotation) is perpendicular to the direction of movement of the carriage or like unit.

There is thus a need for a method of and apparatus for controlling the unloading with greater precision and reliability.

According to the present invention there is provided a method of controlling the unloading from carriages or like units of items to be sorted in a sorting plant, wherein an item to be sorted is placed on a carriage or like unit which is movable along a fixed path and provided with a movable belt movable transversely to the direction of the movement of the carriage or like unit to unload the item carried on the belt, in which, during the unloading stage, the acceleration imparted to the carriage or like unit belt is varied, to control the trajectory and the velocity of the items being unloaded, as a function of the mass of the item.

According to another aspect of the present invention there is provided apparatus for carrying out the above method, including at least one carriage or like unit movable along a fixed path and provided with a movable belt movable transversely to the direction of movement of the carriage or like unit to unload an item carried on the belt, a plurality of magnets secured to an idler roller of the belt, a plurality of sensors secured to the carriage or like unit and operable to detect variation in the magnetic flux

following the rotation of said idler roller in order to generate an electric signal, and means for comparing said electric signal to a reference signal and for varying the current supply to a drive motor of the said belt.

The method concerns the control of both the speed and the unloading trajectories in order to get all the items to be sorted to move as constantly as possible with respect to different speeds of the carriages or like units.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a block diagram of devices for the control of trajectories during unloading which form part of apparatus for carrying out the method of the invention;

Figure 2 shows three graphs of the acceleration to which items to be sorted are subjected during unloading;

Figures 3a-3c show the unloading trajectories of the items at collecting stations;

Figure 4 is a block diagram of drive control devices for a carriage or like unit belt during unloading, as a function of the machine speed; and

Figures 5a-5c show flow diagrams relevant to the functions carried out according to the method of the present invention.

The items handled by a sorting plant have, to a certain extent, different sizes and masses. The prior art methods for discharging the items from movable carriages or like units do not take this into account, whether they are based on unloading by gravitational force, (e.g. tiltable plate units) or when the unit has a loading surface consisting of a movable belt. These known methods just synchronize unloading with the coding given to the item, making it necessary to employ collecting mouths greater than the traditionally used ones, in order to ensure that unloading takes place at the

proper station.

However according to the present method, the unloading trajectories of the items being sorted are controlled as a function of the mass of each item.

What is required is to vary the acceleration of the transversely arranged movable belt of each carriage or like unit during unloading, so as to obtain a speed as constant as possible, whether the item to be sorted has minimum mass (with reference to the smallest item) or the maximum allowed mass.

In fact, should the carriage or like unit belt be subjected to the same acceleration apart from the mass it conveys, the unloading trajectories become constant and predictable, which is all the more significant if one considers that there is a good chance for the item to arrive at the unloading zone at the centre of the unit belt.

The invention enables the setting up of contiguous and relatively small size unloading stations without this giving rise to any sorting errors and, consequently, to any requirement for hand rectification.

It should be pointed out that during operation both the weight and the sizes of the items are detected, by known means, and the relevant data sent to a computer that controls the whole apparatus.

With reference to Figure 1 of the accompanying drawings, control of the unloading trajectories may be described in this manner. On a roller 29, which forms the idler roller of a carriage or like unit unloading belt 12, there are four permanent magnets 30, e.g. of the cobalt or alnico type, having a high degree of magnetization. These magnets 30 are set along the periphery of the roller 29 at 90° to each other, so that the magnetic polarities (N=North and S=South) alternate.

As roller 29 rotates, and the carriage or like unit carrying it moves, there occurs a variation in the magnetic flow produced by the magnets 30,

which is detected by unit sensors 31. These are, for instance, Hall sensors that, as a function of the flow variation and therefore of the speed of the belt-drive, generate an electric signal that is sent to an amplifier 32.

From amplifier 32 the signal is sent to a node 16 of a drive control 14, which node will compare said signal to that of a ramp generator 17.

As during the transit of the item to be sorted on the carriage or like unit, drive control 14 controls the current supply to motor 11 to obtain a constant acceleration of the belt 12 for all the items being unloaded.

For instance, should the carriage or like unit be carrying an item having a considerable mass, the belt 12 would be slowed down or retarded in operation. At node 16 would thus arrive a signal different from that of the generator 17, as belt 12 (and therefore roller 29) has a lower acceleration than that predicted.

Drive control 14, by means of amplifier 18 and feedback 15, would then increase the supply current to motor 11 and thus its speed, until a balance between the signal of the generator 17 and that of sensors 31 is reached.

In Figure 1 are indicated, by way of example, four Hall sensors arranged in pairs, so as to have sixteen impulses available for each complete revolution of the idler roller 29.

Sensors 31, moreover, are arranged so as to form a 45° angle, corresponding to a phase shift of 90° of the magnet-generated signals.

The same magnets 30 are also employed to test the proper running of the carriage or like unit carrying the belt 12. To this end, there is another Hall sensor 33, set on the ground near the fixed path along which the carriages or like units run.

The signal detected by sensor 33 is sent to a converter device 34 that converts said signal into a signal that is a function of the speed movement

of the carriage or like unit.

This speed value is sent from the converter device 34 to a computer 3, which checks that said value corresponds to predetermined parameters.

By this test it is possible to locate those carriages or like units that, owing to a failure, are not in a position to carry out unloading. They are left out of the sorting operations and repaired. The same test also allows an alarm to be set off in the case of an item being particularly heavy and not being unloaded, due to the belt tending to slip on the support or driven roller.

Figure 2 shows the trend of the belt acceleration for three different working conditions. The curves of Figure 2 were compiled from real working conditions.

The data shared by the three curves is as follows. The belt actuation time (800 m/sec) the final speed of the belt (3.25 m/sec) and the instant when the items are being unloaded (after 300m/sec from actuation).

The most significant part of each curve is therefore the initial 300 m/sec during which the unloading takes place.

Curves a, b and c refer to the carriage or like unit being unloaded, to the carriage or like unit being loaded with an item of 5 Kg weight and the carriafe or like unit being loaded with an item of 10 Kg weight, respectively.

By comparing the three curves over the first 300 m/sec, the increase in speed turns out to be the same in all three cases. This means that any item having a weight ranging between null mass and 10 Kg mass is subject to the same acceleration, which results in the discharge speed and trajectories being constant and therefore, calculable with precision.

The part of the curves lying between 300 and 800 m/sec show to the contrary a different trend in each single case. In fact, in th a condition the

belt always revolves unloaded and therefore there is a constant increase in speed over 800 m/sec, whilst both in the b and in the c conditions the curves show a pitch after 300 m/sec, namely after the item has been unloaded and the belt is running without any load.

Figures 3a and 3b show the unloading trajectories, respectively, of a small size square item (5 cm long sides) and of an item whose sizes may be compared to those of the loading surface of the carriage or like unit. These trajectories were obtained by a computer simulation of a real situation. In the same Figures are set out the details relating to the unloading simulation, with the acceleration given by the belt to the item being equal to 14.8 m/sec^2, for either representation. The constant trend of the trajectories will be apparent if one bears in mind (see Figure 3) that the largest size item seems not be discharged perfectly into the collecting station owing to the fact that the motion of the carriage of like unit cannot be shown in the drawing.

Figure 3c shows the trend of the trajectories for a small size item that occupies two extreme positions on the carriage or like unit. In this case too the acceleration value is equal to 14.8 m/sec^2 and the constant unloading trajectories make it possible to unload the item exactly at the relevant collecting station. As in Figure 3b, there is no evidence of the motion of the carriage or like unit, which gives one the impression that the item on the left side of the carriage or like unit would not get into the collecting mouth.

An advantage of the method of the present invention lies in the possibility of unloading the items even when the sorting plant does not work at the rated speed. The carriage or like units of the sorting plant are driven from a rest position to a working speed that is kept constant as the unloading or discharge operations are being carried out. These operations do not start until the working speed is reached, in the relatively short time of 15-20 sec. It may be that, due to an emergency or a failure, the plant is stopped after the carriage or like units have been loaded and, once the emergency has ceased or the failure has been repaired, the plant is started again.

The time necessary for returning to the working speed is as above, but in this case it is still relatively long, as it is possible that the already loaded items have in the meantime reached the unloading or discharge stations.

It is thus necessary on restarting to bring the suspended operations to an end, without this affecting the sorting precision. According to the prior art, this drawback is usually obviated by discharging those items that reach the unloading stations before the plant returns to normal working speed. The discarded items are then put back in the sorting circuit following the customary loading operations.

On the contrary, with the method of the present invention the carriage or like unit belt can be operated in a variable manner, as a function of the speed of the movement of the carriage or like unit. This is very important as a momentary stoppage of the plant now does not involve any repeat of already effected operations, thus ensuring sorting precision and reliability.

Figure 4 shows a carriage or like unit 5 in the proximity of an unloading station 35 where item 1 is to be unloaded. As indicated above, the unloading takes place by feeding current to feed bars 13, from which the belt-unit motor is fed through sliding contacts 36.

When the speed of movement of the carriage or like unit 5 is lower than the working speed (e.g. owing to a momentary stoppage) the method according of the invention allows the unloading still to be carried out, in the following way.

The central computer 3 receives from a main encoder 9 a sequence of impulses according to the actual speed of movement of the carriage or like unit 5, e.g. lower than the working speed.

The computer 3 then compares the speed value with the data inserted in its program and establishes that the motor of the carriage or like unit 5 should be actuated after a certain delay. This delay causes current to be

fed to bars 13, through the drive control 14, when the carriage or like unit 5, and therefore sliding contacts 36, are in a more advanced position than they are usually.

Thus, if at working speed the drive control 14 acts as the first sliding contact 36 is in correspondence with point 37, at lower speed conditions the same drive control will send current to the bars 13 when the sliding contact 36 is in a more advanced position, e.g. at point 38.

In consideration of the lesser speed of the carriage or like units, this delayed actuation allows a predictable unloading trajectory to be obtained and, accordingly, improves the unloading precision.

Figures 5a-5c show flow diagrams relevant to the main functions carried out by a sorting plant operated according to the method of the present invention. Figure 5a refers to the main functions of the present method, namely sequence of the loading, re-positioning at the centre of the carriage or like unit and unloading of the items to be sorted, as well as a test for checking proper working of the belts.

The "automatic coding" diagram indicates the possibility of avoiding the coding operations carried out by the operator, which is obtainable by providing the plant with an automatic code reader or scanner (e.g. post code or bar code) placed before the unloading area. In this way the scanner would automatically scan the destination of the items and would provide the central computer with the necessary data for the unloading.

Figure 5b concerns the control of the main encoder 9, and the unloading stage for the items.

The main encoder 9 is handled by four main blocks, namely a main program, a control program for proper working of the plant, a handling program and an encoder value computing program.

The main encoder 9, in turn, sorts the tasks to be carried out as a function of the encoder value, and updates the item data on a suitable shift

register. The "unit speed control" represents the computing of the carriage or like unit speed each time the unloading should be actuated. At this stage the item is unloaded, by means of the impulses of an imaginary encoder, which impulses are in fact derived from the main encoder 9 as a function of the unit speed.

By means of a pointer reset (a register or item data index that locates the carriage or like unit that is to perform the unloading) and the data control (destination, weight and sizes) the item is unloaded by supplying current to the bus bars that feed the motor of the particular carriage or like units 5.

Once the item has been unloaded, the main encoder 9 deactivates the unloading device, resets the pointers and disconnects the supply current from the bus bars.

Figure 5c shows the carrying out of the test for the proper working of the carriages or like units.

Under the control of the main encoder 9 the unit belt 12 is actuated, and the accuracy speed is feedback controlled. The thus tested carriage or like unit is either enabled or disabled as a function of the result of the previous control.

Actually, this means that a failure - if any - would cause the carriage or like unit not to be utilised. The operation ends as soon as the drive motor of the belt has been turned off.

CLAIMS

1. A method of controlling the unloading from carriages or like units of items to be sorted in a sorting plant, wherein an item to be sorted is placed on a carriage or like unit which is movable along a fixed path and provided with a movable belt movable transversely to the direction of the movement of the carriage or like unit to unload the item carried on the belt, in which, during the unloading stage, the acceleration imparted to the carriage or like unit belt is varied, to control the trajectory and the velocity of the items being unloaded, as a function of the mass of the item.

2. A method according to Claim 1, in which the speed of movement of the belt is detected instant by instant by electric transductors, the signal generated by said transductors is compared to a reference signal, and the current supply to a motor means operable to move the belt is varied in dependence upon the difference of said transductor signal from said reference signal.

3. A method according to Claim 1, in which the speed of movement of the or each unloading belt is correlated with the speed of movement of the or each carriage or like unit.

4. A method according to Claim 3, in which the speed of movement of the or each carriage or like unit is detected by a transductor capable of generating a sequence of electric impulses as a function of said speed, and is then compared to pre-determined reference parameters, and in which the current supply to a drive motor of the belt of the or each carriage or like unit is varied in dependence upon the result of the comparison to adjust the unloading speed of the item on the belt to the forward speed of the particular carriage or like unit.

5. Apparatus for carrying out the method according to Claim 1, including at least one carriage or like unit movable along a fixed path and provided with a movable belt movable transversely to the direction of movement of the carriage or like unit to unload an item carried on the belt, a plurality of magnets secured to an idler roller

of the belt, a plurality of sensors secured to the carriage or like unit and operable to detect variation in the magnetic flux following the rotation of said idler roller in order to generate an electric signal, and means for comparing said electric signal to a reference signal and for varying the current supply to a drive motor of the said belt.

6. Apparatus according to Claim 5, including an additional sensor for controlling the rotary speed of a support or drive roller or the belt.

7. A method of controlling the unloading from carriages or like units of items to be sorted in a sorting plant, substantially as hereinbefore described and as illustrated in the accompanying drawings.

8. Apparatus for carrying out the method according to Claim 1, substantially as hereinbefore described and as illustrated in Figures 1 and 4 of the accompanying drawings.

9. A sorting plant including apparatus according to any one of Claims 5, 6 and 8.

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